CLAIMS

What is claimed is:

1. A method for forming a semiconductor device, the method comprising:

providing a substrate;

forming a material layer over the substrate;

forming a photoresist layer over the material layer;

exposing a top surface of the photoresist layer to a treatment radiation;

forming a protectant layer over the photoresist layer;

removing a portion of the protectant layer to expose an underlying portion of the photoresist layer;

removing the photoresist layer; and

removing portions of the material layer using the protectant layer as a mask.

2. The method as set forth in claim 1, wherein:

the treatment radiation comprises light radiation;

the protectant layer comprises a silylated layer; and

the method comprises an additional step of removing another portion of the protectant layer.

3. The method as set forth in claim 2, wherein the material layer is selected from a group consisting of a group II compound, a group III compound, a group IV compound, a group V compound, and a group VI compound.

4. The method as set forth in claim 2, wherein the material layer is selected from a group consisting of silicon, silicon dioxide, doped silicon dioxide, silicon nitride, poly silicon, aluminum, copper, titanium, titanium nitride, tantalum, and tantalum nitride.

5. The method as set forth in claim 2, wherein the material layer is made of a polymeric resin.

6. The method as set forth in claim 2, wherein the material layer is selected from a group consisting of a dielectric anti-reflective coating, a bottom anti-reflective coating, and a development bottom anti-reflective coating (DeBARC).

7. The method as set forth in claim 2, wherein the photoresist layer is a patterned photoresist layer.

8. The method as set forth in claim 2, wherein the photoresist layer is positive photoresist.

9. The method as set forth in claim 2, wherein the photoresist layer is positive e-beam photoresist.

10. The method as set forth in claim 2, wherein the exposing of the photoresist layer to radiation comprises performing a flood exposure process to alter at least one property of the photoresist layer.

11. The method as set forth in claim 2, wherein the forming a silylated layer over the photoresist layer comprises silylanizing a surface of the photoresist layer.

12. The method as set forth in claim 11, wherein the silylanizing of a surface of the photoresist layer comprises a silylation process being performed in a gas phase.

13. The method as set forth in claim 12, wherein the silylanizing of a surface of the photoresist layer comprises a silylation process being performed in a liquid phase.

14. A structure formed using the method of claim 1.

15. A structure formed using the method of claim 2.

16. A structure formed using the method of claim 9.

17. A method comprising:

providing a substrate having a first layer formed thereon;

forming a second layer on the first layer;

performing a treatment on and forming a protection layer over the second layer;

removing a first portion of the protection layer to expose the second layer;

removing the second layer; and

using the protection layer as an etch mask, removing an exposed portion of the first layer.

18. The method as set forth in claim 17, wherein:

the treatment comprises a flood exposure;

the protection layer comprises a silylated layer; and

the method comprises an additional step of removing a second portion of the protection layer.

19. The method as set forth in claim 18, wherein:

the first layer is a material layer;

the second layer is a patterned photoresist layer; and

the flood exposure comprises exposure to ultraviolet radiation and is performed substantially perpendicularly to the second layer so that a top surface of the second layer is exposed to the ultraviolet radiation.

20. The method as set forth in claim 18, wherein:

the first layer is selected from a group consisting of a group II compound, a group III compound, a group IV compound, a group V compound, and a group VI compound;

the second layer is a photoresist layer; and

the flood exposure alters at least one property of the second layer so that a portion of the second layer can be removed.

21. The method of claim 18, wherein:

the silylanizing of the second layer is performed in a gas phase or in a liquid phase;

the removing of the first portion of the silylated layer to expose the second layer comprises using an etching back process or a chemical mechanical planarization process; and

the removing of the first portion of the silylated layer is terminated before a substantial portion of the second layer is removed.

22. The method of claim 18, wherein:

the silylanizing of the second layer is performed in a gas phase or in a liquid phase;

the removing of the first portion of the silylated layer to expose the second layer comprises using a dry etching process or a wet etching process;

the removing of the second layer comprises using a dry stripping process or a wet stripping process; and

the removing of the second layer is terminated before a substantial portion of the first layer is removed.

23. The method of claim 18, wherein the removing of the second portion of the silylated layer forms a plurality of structures having a pitch that is smaller than a photolithography process will allow.

24. The method of claim 18, wherein the removing of the second portion of the silylated layer is terminated before a substantial portion of the substrate is removed.

25. A structure formed using the method of claim 17.

26. A structure formed using the method of claim 18.

27. A method for forming a semiconductor device having a reduced pitch, the method comprising:

forming a material layer on a substrate;

forming a patterned photoresist layer on the material layer;

exposing the patterned photoresist layer to ultraviolet radiation to alter at least one property of the patterned photoresist layer so that a cross-link degree of a portion of the patterned photoresist layer is reduced;

silylanizing the patterned photoresist layer in a gas phase or in a liquid phase by diffusing silylamine into the patterned photoresist layer and forming a silylated layer over the surface;

removing a first portion of the silylated layer to expose the patterned photoresist layer using an etching back process or a chemical mechanical planarization process;

removing the patterned photoresist layer using a plasma gas;

using the silylated layer as an etch mask, removing an exposed portion of the material layer; and

removing a second portion of the silylated layer to form a plurality of structures having a pitch that is smaller than a photolithography process will allow.

28. The method of claim 27, wherein:

the plasma gas comprises ozone; and

the removing of the second portion of the silylated layer is terminated before a substantial portion of the material layer is removed.